Psychology 263: Introduction to Cognitive Processes

Attention: Bottleneck and Capacity

Attention: Bottleneck

1. Attention and Effort
2. Four Kinds of Attention
   1. alerting, vigilance, divided, selective
3. Capacity Limitation
   1. early vs late selection
4. Broadbent's Filter Theory
   1. dichotic listening and shadowing
5. Inattentional & Change Blindness

Attention

- Allows us to make sense of the world around us and to focus on the things that interest us

- There is far too much going on around us to take in at a time, we need to be selective

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Definition

- ***Attention***: a focusing of perception that leads to greater consciousness of a limited number of (dimensions of) stimuli; the focusing of mental effort on sensory and/or mental events

- ***Focusing*** = selective orientation
- ***Consciousness*** = awareness
- ***Mental Effort*** = concentration
- Note: attention can be exerted internally, externally, or both

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Four Kinds of Attention

- Alerting
- Vigilance
- Selective (focused)
- Divided

Attention: Detection

- ***Alerting***: the ability to orient oneself to some critical and/or unexpected stimulus; specialized detectors with high priorities…most primitive form of attention (just detects signals)

- ***Vigilance***: the ability to devote full attention to a single stimulus (complex); detection of change has high priority

Attention: Detection

- Alerting and vigilance tie into pattern recognition and the process of detection
- These were important areas of study during WW2 when equipment design in aircrafts, tanks, etc. required alerting and vigilance
- Where should gauges/controls be? What type of warning lights should be used?
- Cognitive ergonomics

Attention: Concentration

- In modern day psychology, we are more concerned with the aspects of attention that seem more under our control…selective and divided
- You can think of these things as concentration

Attention: Concentration

- *Selective*: the ability to choose to focus on only one stimulus (or dimension), excluding all others

- *Divided*: the ability to focus on two (or occasionally more) stimuli/dimensions at the same time; usually, there is some loss in attention to one or both

Attention: Concentration

- If you have bad attention can you improve it?
- To a degree, yes. Attention is learned (air traffic controllers and baggage handlers go through a lot of training
- Want proof…distract a little kid from something he/she is doing for 5 seconds and see if they go back to it
- When people say they have a bad memory the actually mean they have bad attention

Attention: Concentration

- Note: even though attention can be learned/improved, it can also collapse on us
- Schizophrenics:
- "I have noticed a lot recently that I seem to get a little mixed up about where sounds are coming from. Often I have to check up if someone speaks to me and several times I thought someone was shouting through the window when it was really the radio at the front of the house."
- I've had difficulty in tracing where sounds are coming from although I am not deaf. If the radio is on, for example, I know the radio is there but sometimes I feel that the sounds are coming from behind my back.
- (McGhie & Chapman, 1961)

Selective and Divided attention

- Selective and divided attention are flip sides of the same coin: divided attention is the splitting of attention, selective attention is the focusing of attention

- Let's start with selective (reading example)

Selective attention

- Attention functions well when within its capabilities, but it can fail when overloaded

- Example: Listening to conversations at a party (limited capacity)

Divided attention

- Similarly, difficult to take in more than one message at a time

Dichotic listening

- Two messages are being spoken/read to you at the same time…can you understand both, can you select one?

- Gonna need two volunteers here

Question

- Why can attention only focus on a limited number of inputs?

- Theories aimed at addressing this are bottleneck theories (trying to figure out what gets selected and how)

- First theory to try to account for this: Filter theory

Donald Broadbent

- presented theory in his book, Perception and Communication (1958)
- one of the first information processing theories
- the filter idea strongly influences theories of attention even today
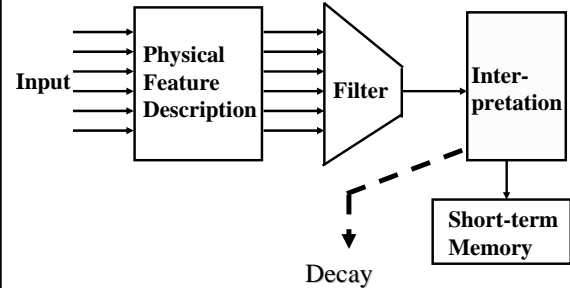

Broadbent

- Key idea to filter theory is that information processing is limited by channel capacity (only so much information can be conveyed along a channel at one time)
- Only one channel can be processed at a time (single channel hypothesis)

Broadbent

- Selection occurs prior to pattern recognition…no stimuli can be identified until after selection (similar to Sperling's finding that partial report was not possible with category cues)
- Critical prediction: **Selective attention should not be affected by the identity of various messages**

Broadbent's Filter (1958)

Dichotic listening

- Initial evidence was consistent with Broadbent's theory
- Dichotic listening experiments: Pairs of digits being presented in groups of 3…one item in each ear
- Conditions: report what is being presented to one of your two ears or report what is being presented in each ear in order (left then right, left then right)
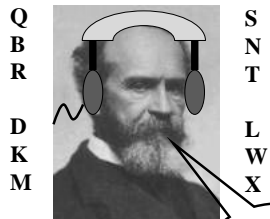
Dichotic Listening

Right Ear — Q B R D K M

Left Ear — S N T L W X
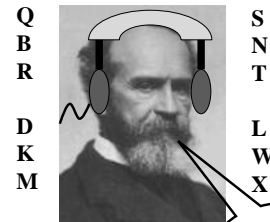
William:
Please shadow your left ear…

"s" "n" "t" etc …

Dichotic Listening

Right Ear — Q B R D K M

Left Ear — S N T L W X

William:
Please shadow pairs in order…

"q" "s" "b" "n" etc …

Results

- People reporting only what was in one ear got everything right 65% of the time
- People reporting the pairs were right only 20% of the time
- If you think of ears as channels, the requirement to switch back and forth between channels hurt performance

More evidence for filter theory

- In tasks in which a distractor is presented very close in time to a target, responding is slow (distractor and target compete for single channel?)
- In tasks where people are asked to shadow one message while ignoring the other, if later asked questions about the unattended channel they know nothing (even if the unattended channel is just a word repeating over and over)

Problems for filter theory

- Gray and Wedderburn: split messages over channels and showed that subjects put them back together easily

Gray & Wedderburn (1960)

	Left Ear	Right Ear
Exp. 1	OB	6
	2	JEC
	TIVE	9
Exp. 2	What	3
	5	the
	hell	4

Anne Treisman

- critical experiments on identification, meaning, and attention (1960)
- continues to be one of the most influential attention researchers today

Treisman (1960)

- Attended/shadowed (left):
  .... *sitting at a mahogany* **three** *objects*

- Unattended (right):
  .... **let us examine these** *table* **with her**

- *should* shadow the attended channel, but instead says what is in italics. Meaning "pulls" you to the other channel

Wood & Cowan (1995)

- shadowing one channel
- some subjects notice their name on the unattended channel (see Cherry, 1953)
- Slip of attention to unattended channel based on meaning (contrary to filter theory?)
- but *if* a subject notices her/his name, *then* there is always disruption of shadowing over the next few seconds
- evidence that we sometimes slip and attend to the wrong channel, but this has a cost
- This is one of the assigned articles a few weeks from now

More on attentional capacity

Inattentional Blindness

- Mack & Rock (1998)

- definition: the failure to see consciously, caused by lack of attention
- we can miss perceiving very obvious changes   if we are not attending

- website with demos:
- http://www.wjh.harvard.edu/~viscog/grafs/dem os/

Inattentional blindness

- Task is even harder/people are more likely to miss the gorilla if the people are made transparent (requires more effort to track)
- Transparent basketball video

Change Blindness

- Levin & Simons (1997)
- Rensink, O'Regan, & Clark (1997)

- definition: a remarkable inability to detect changes in displays, even when trying
- attention is crucial to perception and memory

Simons & Levin

- This week's paper
- Strangers are approached on the street and asked for directions
- At some point during the interaction, two people walk by holding a door
- While the door is blocking the interaction, the individual who asked for directions is switched out with someone holding the door, that person continues to get directions
- Very few people notice the switch
- Show video

Other ways this real world work has been done

- Professor/TA dropping down under his desk to get someone's test paper, different person comes up with it

What if people are told about changes?

- In the previous experiments, participants were unaware of changes, but a big reason for this is they were not expecting changes. What if we're aware that changes are going to occur

- Phone call (easy one)
- Conversation (harder)

Flicker paradigm

- Most common way to study change blindness is via the flicker paradigm
- Two pictures are presented back to back to participants with one small difference between the two pics. This change is very easy to notice.
- If, rather than showing the pics back to back, a brief flicker screen is presented between the pictures...now the change is very difficult to find

Change blindness

- Often, we do not even notice these changes, no matter how bizarre/obvious
- Sometimes we have a "sense" of when things are amiss in our environment, not here...unfortunate byproduct of how the visual system works to maintain consistency when eyes move quickly

Is the flicker necessary?

- Slow motion change blindness
- A change occurs gradually in the scene and again, even if you're looking for it it is often hard to see
- Show videos
  - Paris (easy)
  - Living room (harder)
  - River (harder still)

Change blindness - relevance

- It's not often our vision is interrupted by 100 millisecond duration grey rectangles covering our visual field, right? WRONG.
- When people make saccades, our vision is degraded (saccadic blindness), due to the eyes rotating at hundreds of degrees per second- too rapidly for the retina to integrate useful information.
- ***We spend 10-20% of our waking lives functionally blind.***
- That this is something of which we are not generally aware is perhaps the greatest illusion of all time, and illustrates the brain's immense capacity for self-delusion.

Attention: Capacity

1. Capacity & Resources
2. Arousal and the Yerkes-Dodson Law (1908)
3. Kahneman's (1973) Capacity Model
   1. allocation, resources, & demands
4. Priming
   1. validity
   2. costs & benefits

Attention

- Problems with filter theory led researchers to think they needed a different kind of theory
- New view is that attention works in terms of capacity: we have limited resources available to us and how we allocate those resources are important
- Important idea for capacity theories: amount of capacity is influenced by level of arousal

Arousal

- Definition: a general state of activation with respect to our capacity to perceive sensory events
- An important aspect of attention/performance
- Too little arousal leads to poor performance (e.g. lack of effort)
- Too much arousal leads to poor performance (e.g. distracted)
- Weapon focus, nudes, etc. (we'll cover this during memory)
- Get in the house, someone is coming to get you!

Yerkes-Dodson Law (1908)
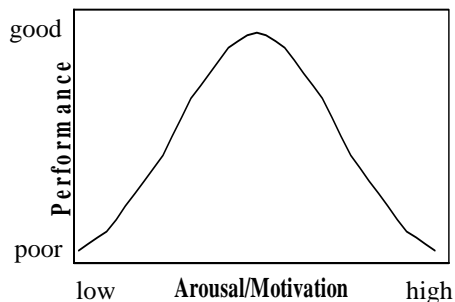
Critical idea here

- Arousal influences selectivity: Low arousal = low selectivity
- High arousal = high selectivity but only to a point (if arousal is too high performance decreases)

Daniel Kahneman

- from his book, Attention & Effort (1973)
- related arousal and performance, using attentional control
- also a leader in the area of judgment and decision making

Kahneman's capacity theory

- Performance is influence by both arousal and processing limitations
- We have some control over how capacity is allocated to various tasks (e.g. driving on a busy road…turn down the radio)
- All tasks compete for the same pool of resources but tasks vary as to how much attention they require (two simple tasks can be carried out quite easily at the same time…now two difficult tasks)

Kahneman's Capacity Theory
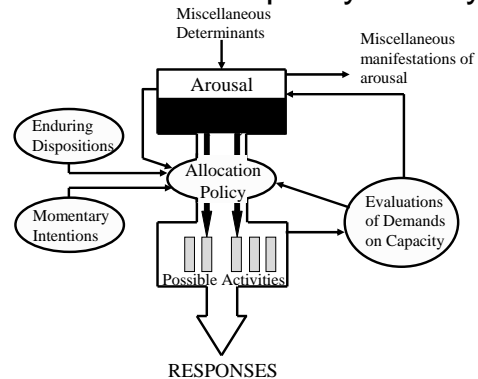
Another important influence of attention

- Priming: prior experience processing a sensory input leads to enhanced processing the next time around

- There are many different forms of priming…we'll start off with two
- Did you notice that after doing a couple of change blindness experiments, they got easier?

Priming

- **Cognitive task**: an experimentally constructed situation for studying a particular small set of cognitive skills or activities

- **Priming**: a previous encounter with the identical stimulus or a related stimulus (the **prime**) makes subsequent processing of that stimulus (the **target**) easier

- e.g., Zajonc (1980) – the "mere familiarity" effect

Michael Posner

- has done classic studies on attention and also memory
- Posner & Snyder (1975) as an illustration of priming
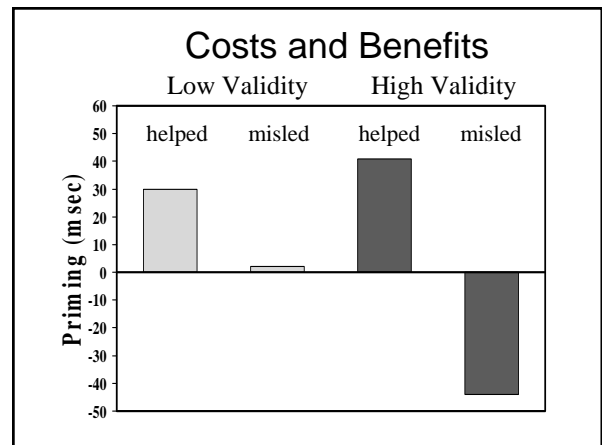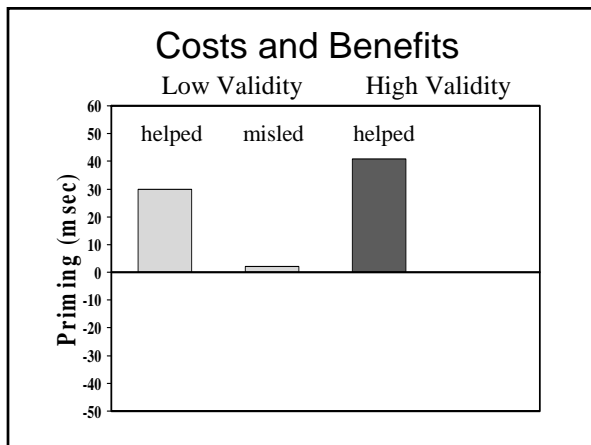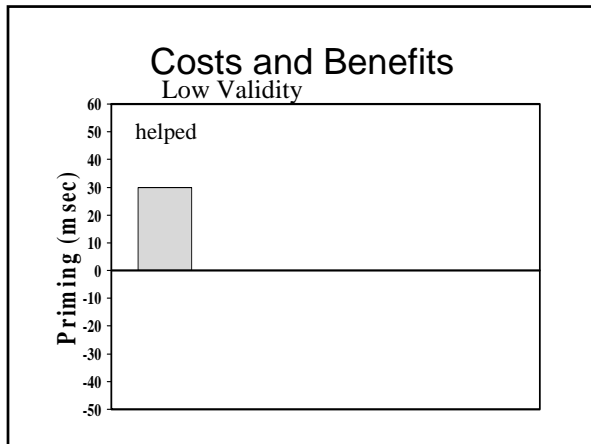- now a leading researcher in the new field of cognitive neuroscience

How to measure priming

- Look at performance to respond to something as a function of what preceded it

- Posner task: Letter pairs presented…you say if they are the same or different

- Prior to the letter pairs, a cue stimulus appears which is either neutral, helpful, or hurtful (prime validity also manipulated to let people know whether they should be attending the cue)

Posner & Snyder (1975)

- 3 types of same trials:

	Prime	Target
– neutral:	+	A A
– helped:	H	H H
– misled:	D	F F

- Different trials are just there to mix things up…interested in performance on same trials
- priming could be 80% "helped," which is called high validity priming, or 80% "misled," which is called low validity priming

Costs and Benefits

Low Validity

helped

Priming (m sec)

60
50
40
30
20
10
0
-10
-20
-30
-40
-50

Costs and Benefits

Low Validity

helped   misled

Priming (m sec)

60
50
40
30
20
10
0
-10
-20
-30
-40
-50

Costs and Benefits

Low Validity   High Validity

helped   misled   helped

Priming (m sec)

60
50
40
30
20
10
0
-10
-20
-30
-40
-50

Costs and Benefits

Low Validity   High Validity

helped   misled   helped   misled

Priming (m sec)

60
50
40
30
20
10
0
-10
-20
-30
-40
-50

Explaining Costs & Benefits

- benefit 1: stimulus-driven (bottom-up, automatic), due to repetition; fast acting
- benefit 2: conceptually drive (top-down, controlled), due to expectation; slower acting

- cost: due to limited capacity, preparing the wrong detector based on an incorrect expectation "wastes" valuable resources

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Capacity

- Moving attention throughout the environment involves understanding our limits, determining our goals, and allocating our resources accordingly
- Sometimes this is easy (e.g. making a phone call)
- Sometimes this is difficult (e.g. pat your head and rub your belly)
- Next class: Automaticity